

REMARKS/ARGUMENTS

The title has been amended to better reflect the fact that claims 5-8, which are pending in this application, are method claims. Reconsideration for allowance of claims 5-8 is respectfully requested in light of the following remarks.

Claims 5-8 stand rejected under 35 U.S.C. § 112, first paragraph, as allegedly being based on a defective specification. The Examiner opines that the Declaration Under 37 C.F.R. § 1.132 by Mr. Kouchi Nagamoto indicates that certain embodiments of the invention do not work and contradicts an essential portion of the specification. Applicants strongly disagree with the Examiner's position and assert that the Examiner has taken the data and results out of context.

What Applicants "... claim as patentable to them is *less* than what they describe as their invention is not conclusive if their specification also reasonably describes that which they do claim." In re Wertheim 541 F.2d 257, 191 USPQ 90, 97 (CCPA 1976). The specification describes a pressure sensitive adhesive sheet that includes a substrate and a pressure sensitive adhesive layer thereon, which can precisely follow the irregularities of an adherend surface. In view of the cited prior art, the claims have been amended to include only pressure sensitive adhesive sheets having a $\tan \delta$ of 0.78 to 1.6%. In other words, Applicants narrowed the scope of the claims to a $\tan \delta$ range of 0.78 to 1.6%. See page 21, Table 1 of the specification. The Declaration filed on February 3, 2003 by Mr. Kouchi Nagamoto referred to the amended claims and not to the invention in general. The Examiner has taken the statements out of context, possibly due in part to English not being the inventor's native language. The Declaration merely shows species that fall within the claimed $\tan \delta$ range and those that do not. Therefore the

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rejection under 35 U.S.C. § 112 is inappropriate, and Applicants respectfully request that the rejection be withdrawn.

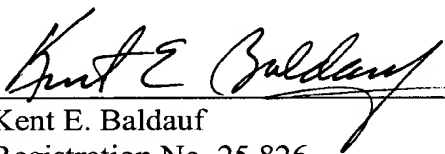
Claims 5-8 stand rejected under 35 U.S.C. § 102(a) as being anticipated by or in the alternative under 35 U.S.C. § 103(a) as being obvious over either JP 11-016863 or JP 10-189504. The present application claims priority based on Japanese Patent Application No.10-152835, which was filed on June 2, 1998. Enclosed herewith is a verified translation of the priority document. As can be seen from the translation, Applicants have perfected their priority claim to JP 10-152835. The publishing date for JP 11-016863 is January 22, 1999, and the publishing date for JP 10-189504 is July 21, 1998. Both patents were published after the priority date of the present invention. Therefore, the rejections under 102(a) and 103(a) are improper and Applicants respectfully request that they be withdrawn.

In view of the foregoing remarks, it is believed that the present application is in condition for allowance. Reconsideration of the rejections and allowance of claims 5-8 are respectfully requested.

Respectfully submitted,

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DECLARATION

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I, HONDA Yayoi, do solemnly and sincerely declare that I understand the Japanese language and the English language well, and that the attached English version is a full, true and faithful translation made by me of Japanese Application for Patent No.152835/1998.

I make this solemn declaration conscientiously believing the same to be true.

June 6, 2003

HONDA Yayoi

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following
application as filed with this office.

Date of Application: June 2, 1998

Application Number: 152835/1998

Applicant(s) : LINTEC CORPORATION

Commissioner,
Patent Office

(Sealed)

Application: Application for Patent
Reference Number: 98T194P010
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Title of the Invention:

ADHESIVE SHEET AND METHOD OF USE THEREOF

Number of Claims: 3

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List of the Appended Documents:

Specification 1

Abstract 1

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[Document] SPECIFICATION

[Title of the Invention]

ADHESIVE SHEET AND METHOD OF USE THEREOF

[Claims]

5 1. An adhesive sheet comprising a substrate having the maximum value of $\tan\delta$ showing a dynamic viscoelasticity at a temperature of from -5 to 80°C , and an adhesive layer superimposed on the substrate.

10 2. An adhesive sheet according to claim 1, wherein the substrate has a product of a thickness and Young's modulus of from 0.5 to 100 kg/cm .

15 3. A method of use of the adhesive sheet claimed in claim 1 or 2, comprising applying the adhesive sheet to the surface of an adherend and subjecting the adherend to back surface working while protecting the adherend surface by the adhesive sheet.

[Detailed Description of the Invention]

[0001]

20

[FIELD OF THE INVENTION]

The present invention relates to an adhesive sheet. More particularly, the present invention relates to an adhesive sheet which, at the time of working of the back surface of an adherend having a great uneven surface, is formed on the adherend surface by sticking to thereby protect the adherend surface.

25

[0002]

BACKGROUND OF THE INVENTION

In the step of grinding the back surface of a semiconductor wafer, the front surface having electrical circuits formed is protected by an adhesive sheet. The height differences of customary circuits attributed to electrode elements have been from about 5 to 20 μm . The wafer having such customary circuits formed can be sufficiently protected using conventional surface protective sheets. The use of sheets can cope with the protection sufficiently without the occurrence of circuit breakage or wafer cracking.

[0003]

However, in recent years, the method of mounting IC chips is being diversified. For example, the packaging method in which an IC chip circuit surface is arranged down has been developed. In this packaging method, electrode elements protrude from the circuit surface and the height differences thereof are 30 μm or more, occasionally greater than 100 μm .

When the back surface of the wafer having such convex electrode elements formed thereon is ground with using the conventional surface protective sheet, the back surface sometimes is deeply ground at portions corresponding the convex elements to thereby form concave (dimples) on the back of the wafer. Further, sometimes dimple portions crack to result in breakage of the wafer.

[0005]

A similar problem is encountered with respect to ink (bad mark) provided for marking of failure circuits after the inspection of the wafer circuits.

Such convex portions formed on the surface of semiconductor wafers are referred to as bumps. For the semiconductor wafers having large bumps, measures have been taken, which include, for example, decreasing the hardness of the substrate film of the surface protective sheet and increasing the thickness of the adhesive sheet. These measures, however, have been unsatisfactory, and the above problems have not yet been resolved.

[0006]

[OBJECT OF THE INVENTION]

The present invention has been intended in view of the above state of the prior art. It is an object of the present invention to provide an adhesive sheet which, in working of the back surface of an adherend having a surface of a great unevenness, is preferably used by sticking to the adherend surface to thereby protect it.

[0007]

[SUMMARY OF THE INVENTION]

The adhesive sheet of the present invention comprises a substrate having the maximum value of $\tan\delta$ showing dynamic viscoelasticity at a temperature of from -5 to 80°C , and an adhesive layer superimposed on the substrate.

[0008]

The substrate preferably has a product of a thickness and Young's modulus of from 0.5 to 100 kg/cm.

According to the present invention, the adhesive sheet for surface protection which sheet precisely follows the unevenness formed on the adherend surface and absorbs the unevenness, and can be smoothly performed to back surface grinding without influence of the unevenness of the surface is prepared.

[0009]

[DETAILED DESCRIPTION OF THE INVENTION]

The present invention will be described in detail below.

The adhesive sheet of the present invention comprises a substrate and, superimposed thereon, an adhesive layer.

[0010]

The substrate has the maximum value of dynamic viscoelasticity $\tan \delta$ (hereinafter simply referred to as " $\tan \delta$ value") of at least 0.5, preferably 0.5 to 2.0, and still preferably 0.7 to 1.8 at a temperature of from -5 to 80°C. The terminology " $\tan \delta$ " used herein means the loss tangent which defines the ratio of loss elastic modulus/storage elastic modulus. It is measured by the use of a dynamic viscoelasticity measuring instrument on the basis of response to a stress such as tension or torsion applied to an object.

[0011]

In the present invention, the above substrate desirably have a product of thickness and Young's modulus in the range of preferably 0.5 to 100 kg/cm, more preferably 1.0 to 50 kg/cm, further preferably 2.0 to 40 kg/cm. The thickness of the substrate is preferably

from 30 to 1000 μm , more preferably 50 to 800 μm , further preferably 80 to 500 μm .

[0012]

The substrate is composed of a resin film, the type of the
5 substrate is not particularly limited as long as it has the above properties. The resin per se may have the above properties or the resin may have the properties by blending with additives. The substrate may be prepared by conducting film formation of a hardening resin and curing the film, or conducting film formation
10 of a thermoplastic resin.

[0013]

Usable examples of the hardening resin may include a photo-setting resin or a thermo-setting resin, preferably the photo-setting resin.

15 Preferably usable examples of the photo-setting resin may include resin compositions comprising a photo-polymerizable urethane acrylate oligomer as a main component or polyene-thiol resins.

[0014]

20 The urethane acrylate oligomer is obtained by allowing a terminal isocyanate-having urethane prepolymer obtainable by reaction of a polyester or polyether type polyol compound with a polyisocyanate compound such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate,
25 1,4-xylylene diisocyanate or diphenylmethane-4,4'-diisocyanate, to react with an acrylate or methacrylate having a hydroxyl group

such as 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate, 2-hydroxypropyl methacrylate, polyethylene glycol acrylate or polyethylene glycol methacrylate. This urethane acrylate oligomer has a photo-polymerizable double
5 bond in its molecule and undergoes polymerization and curing by irradiation with light to thereby form a film.

[0015]

The urethane acrylate oligomers preferably used in the present invention have a molecular weight of 1000 to 50,000, especially
10 2000 to 30,000. The urethane acrylate oligomers may be used singly or in combination with two or more.

[0016]

There are many cases that the film formation is difficult by only the use of the above urethane acrylate oligomer. Thus,
15 films are generally prepared by diluting the urethane acrylate oligomer with a photo-polymerizable monomer, conducting film formation and hardening the film. The photo-polymerizable monomer has a photo-polymerizable double bond in its molecule, and, in the present invention, an acrylic ester compound having
20 a relatively bulky group is preferably used.

[0017]

Examples of the photo-polymerizable monomer employed for diluting the urethane acrylate oligomer may include:

alicyclic compounds such as isobornyl (meth)acrylate,
25 dicyclopentenyl (meth)acrylate, dicyclopentanyl (meth)acrylate,

dicyclopentenylloxy (meth)acrylate, cyclohexyl (meth)acrylate and adamantane (meth)acrylate;

aromatic compounds such as benzyl acrylate; and

heterocyclic compounds such as tetrahydrofurfuryl

5 (meth)acrylate, morpholinyl acrylate, N- vinylpyrrolidone and N-vinylcaprolactam. Further, polyfunctional (meth)acrylates may be used optionally.

[0018]

The above photo-polymerizable monomer is used in an amount
10 of preferably 5 to 900 parts by weight, preferably 10 to 500 parts by weight, and more preferably 30 to 200 parts by weight based on 100 parts by weight of the urethane acrylate oligomer.

[0019]

The photo-polymerizable polyene-thiol resin used in
15 production of the substrate comprises a polyene compound having no acryloyl group and a polythiol compound. Specifically, the polyene compound is, for example, diacrolein pentaerythritol, a trimethylolpropanediallyl ether adduct of tolylene diisocyanate and unsaturated allylurethane oligomer. The polythiol compound
20 is, for example, mercaptoacetic acid or mercaptopropionic acid ester of pentaerythritol, and further, commercially available polyene polythiol oligomers. The polyene-thiol resin for use in the present invention has a molecular weight of from 3000 to 50,000, more preferably 5000 to 30,000.

25 [0020]

In the case of forming the substrate from the photo-hardening resin, the time required for polymerization and hardening with photo-irradiation and the photo-irradiation dose can be reduced by mixing a photo-polymerization initiator with the resin.

5 [0021]

Examples of this photopolymerization initiator may include a photoinitiator such as a benzoin compound, an acetophenone compound, an acylphosphine oxide compound, a titanocene compound, a thioxanthone compound or a peroxide compound or a photosensitizer
10 such as amine or quinone. Specific examples thereof include 1-hydroxycyclohexyl phenyl ketone, benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzyl diphenyl sulfide, tetramethylthiurammonosulfide, azobisisobutyronitrile, dibenzyl, diacetyl and β -chloroanthraquinone.

15 [0022]

The photopolymerization initiator is added in an amount of preferably 0.05 to 15 parts by weight, more preferably 0.1 to 10 parts by weight, and further preferably 0.5 to 5 parts by weight based on 100 parts by weight of the resin total.

20 [0023]

The above hardening resin can be prepared by selecting various blending combinations of oligomers and monomers so that it has the above physical properties.

Examples of the thermoplastic resin for use in the substrate
25 may include polyolefin resins such as polyethylene, polypropylene, polybutene, polybutadiene, polymethylpentene,

styrene-vinylisoprene block copolymer and hydrogenated styrene-vinylisoprene block copolymer. Particularly, polymethylpentene, styrene-vinylisoprene block copolymer or hydrogenated one is preferred.

5 [0024]

The styrene-vinylisoprene block copolymer is generally an SIS (styrene-isoprene-styrene block copolymer) having a high content vinyl group. Both the styrene-vinylisoprene block copolymer and the hydrogenated one per se have a high peak of
10 $\tan \delta$ at about room temperature.

[0025]

Additives capable of enhancing the $\tan \delta$ value are preferably added to the above resin. Examples of the additives capable of enhancing the $\tan \delta$ value include inorganic fillers such as calcium
15 carbonate, silica and mica and metal fillers such as iron and lead. Especially, the addition of metal fillers having a high specific gravity is effective.

[0026]

Further, the substrate may contain other additives, for
20 example, colorants such as pigments and dyes in addition to the above components.

In the film forming method, for example, a liquid resin (resin obtainable before hardening, resin solution) is subjected to casting into a thin film on a processed sheet, and then made into
25 a film with a prescribed process, to prepare the substrate. In this method, the stress upon the resin during the film formation

is slight, so that the formation of fish eye (small circle solid formed in the film) is slight. Moreover, the uniformity of the film thickness is high and the thickness precision generally falls within 2%.

5 [0027]

Another preferred method of film forming comprises extrusion molding with a T die by an inflation process or a calender process.

Corona treatment or superimposition of another layer such as primer may be effected on the upper surface of the substrate, 10 namely the side furnished with the adhesive layer, in order to improve the adherence to the adhesive layer.

[0028]

The adhesive sheet of the present invention is prepared by superimposing the adhesive layer on the above substrate. When 15 the adhesive layer comprises an ultraviolet curable adhesive, a transparent substrate is used.

[0029]

The adhesive layer can be formed from various conventional pressuresensitive adhesives. These pressuresensitive adhesives, 20 which are not limited, may include rubber, acrylic, silicone and polyvinyl ether based adhesives. Further, radiation curable, heat foaming and water swelling adhesives can be used.

[0030]

The thickness of the adhesive layer, depending on the type 25 of employed material, is generally about from 3 to 100 μm , preferably about 10 to 50 μm .

Various adhesives can be used as the above adhesive without any particular limitation. Preferably usable examples of the radiation curable (light curable, ultraviolet curable or electron beam curable) adhesive may include JP-B-1(1989)-56112 and
5 JP-A-7(1995)- 135189, which are not limiting. In the present invention, it is especially preferred to employ ultraviolet curable adhesives. Moreover, Preferably usable examples of the water swelling adhesive may include those as described in JP-B-5(1993)-77284 and JP-B- 6(1994)-101455.

10 [0031]

The adhesive sheet of the present invention is prepared in the following step. A variable substrate is coated with the above adhesive in appropriate thickness according to the conventionally known process such as comma coater, gravure coater, die coater
15 or reverse coater and dried the adhesive, to form an adhesive layer on the substrate. Then a release liner is optionally applied onto the adhesive layer.

[0032]

The adhesive sheet of the present invention is used to protect
20 the surface of various items and to effect temporary fixing at the time of precision working. In particular, the adhesive sheet is suitably used as one for protecting the circuit surface during grinding of the back of semiconductor wafers. The adhesive sheet of the present invention comprises the substrate having the above
25 specific properties and hence effectively absorbs the unevenness of the circuit surface. Therefore, the adhesive sheet of the

present invention can be stuck with satisfactory bonding strength to bumps-formed wafers having a large surface irregular height difference. Further, the adhesive sheet can relieve the influence of the irregularities of the wafer surface on the back grinding so that wafer breakage can be avoided and also extremely smooth grinding can be performed. Moreover, when the adhesive layer is formed from the ultraviolet curable adhesive, the adhesive strength can be easily reduced by ultraviolet irradiation, so that, after the completion of required working, the adhesive layer can be easily released by irradiating the adhesive layer with ultraviolet rays.

[0033]

[EFFECT OF THE INVENTION]

This invention provides a surface protective adhesive sheet, which can precisely follow the unevenness of an adherend surface to thereby absorb the uneven height difference, and which, in grinding of the back of the adherend, enables accomplishing smooth back grinding without being affected by the unevenness of the adherend surface.

[0034]

[EXAMPLES]

The present invention will further be illustrated below with reference to the following non-limiting Examples.

[0035]

In the following Examples and Comparative Examples, the "back grinding aptitude test" was carried out in the following manner.

Back grinding aptitude test

The following dotted bad marks by printing as bumps were provided on a 6-inch mirror wafer. Each adhesive sheet was stuck to the bad mark-formed surface of the wafer, and the opposite
5 surface of the wafer was ground. The wafer configuration, grinding conditions and evaluation method are as follows.

(1) Wafer configuration

Thickness of wafer (thickness of no dot-printed portion):
650 to 700 μm ,

10 Dot diameter: 500 to 600 μm ,

Dot height: 70 μm , and

Dot pitch: 10 mm interval (overall printing);

(2) Back grinding conditions

Finished thickness: 200 μm , and

15 Grinding apparatus: grinder DFG 840 manufactured by Disco Corporation; and

(3) Evaluation method

Ground wafer back was observed. When there was no crack or dimple or when dimples were observed but the maximum depth thereof
20 was less than 2 μm , the wafer was evaluated as "good". On the other hand, when dimples were observed and the maximum depth thereof was 2 μm or more, the wafer was evaluated as "dimpled".

[0036]

The $\tan \delta$ was measured by a dynamic viscoelasticity measuring
25 instrument at a 110 Hz tensile stress. Specifically, each substrate was sampled into a predetermined size, and the $\tan \delta$

was measured at a frequency of 110 Hz and at temperature of from -40 to 150°C with the use of Rheovibron DDV-11-EP manufactured by Orientec Corporation. The maximum value of measured $\tan \delta$ at temperature of from -5 to 80°C was employed as "tan δ value".

5 [0037]

The Young's modulus was measured at a test speed of 200 mm/min in accordance with Japanese Industrial Standard K7127.

[0038]

Example 1

10 50 parts by weight of urethane acrylate oligomer having a weight average molecular weight of 5000 (produced by Arakawa Chemical Industry Co., Ltd.), 50 parts by weight of isobornyl acrylate, 2.0 parts by weight of photo-polymerization initiator (Irgacure 184 produced by Ciba-Geigy, Ltd) and 0.2 part by weight
15 of phthalocyanine pigment were blended, thereby obtaining a photo-hardening resin composition.

[0039]

A PET film (produced by Toray Industries, Inc., thickness: 38 μm) as a casting processing sheet was coated with the above
20 resin composition in a thickness of 110 μm with the fountain die process, thereby forming a resin composition layer. Immediately after the coating, the resin composition layer was laminated with the same PET film and thereafter irradiated with ultraviolet rays emitted from a high pressure mercury lamp (160 W/cm, distance
25 10 cm) at a dose of 250 mJ/cm² so that the resin composition layer was crosslinked and cured. Thus, a substrate film of 110 μm

thickness was obtained. The $\tan \delta$ and Young's modulus of this substrate film were measured by the above methods. The results are given in Table 1.

[0040]

5 One side of this substrate film was coated with an adhesive composition prepared by blending 100 parts by weight of an acrylic adhesive (copolymer of n-butyl acrylate and acrylic acid), 120 parts by weight of an urethane acrylate oligomer having a molecular weight of 8000, 10 parts by weight of a curing agent (diisocyanate
10 type compound) and 5 parts by weight of a photo-polymerization initiator (benzophenone type compound), and dried. Thus, an adhesive layer of 20 μm thickness was formed to obtain an adhesive sheet.

[0041]

15 The back grinding aptitude test of the obtained adhesive sheet was conducted. The results are given in Table 1.

[0042]

Example 2

 The same procedure of Example 1 was repeated except that
20 morpholine acrylate was used in place of isobornyl acrylate. The results are given in Table 1.

[0043]

Example 3

 The same procedure of Example 1 was repeated except that a
25 mixture of 25 parts by weight of isobornyl acrylate and 25 parts by weight of morpholine acrylate was used in place of 50 parts

by weight of isobornyl acrylate. The results are given in Table 1.

[0044]

Example 4

5 A 60% toluene solution of styrene-vinylisoprene block copolymer (Hybrar VS-1 produced by Kuraray Co., Ltd.) was subjected to casting on the same support film as in Example 1, and dried at 100°C for 2 minutes without lamination and ultraviolet irradiation. Thus, a 300 μm thick substrate film having the tan
10 δ value and Young's modulus shown in Table 1 was obtained.

[0045]

 An adhesive sheet was prepared using the obtained substrate film in the same manner as in Example 1. The back grinding aptitude test of the obtained adhesive sheet was conducted. The results
15 are given in Table 1.

[0046]

Example 5

 In place of the photo-hardening resin composition of Example 1, a polyene-thiol resin (BY-314 produced by Asahi Denka Kogyo
20 K.K.) was formed into a film and cured in the same manner as in Example 1, thereby obtaining a substrate film of 250 μm thickness. The tan δ and Young's modulus of this substrate film were measured by the above methods. The results are given in Table 1. An adhesive sheet was prepared using the obtained substrate film in the same
25 manner as in Example 1. The back grinding aptitude test of this adhesive sheet was conducted. The results are given in Table 1.

[0047]

Example 6

The same procedure of Example 1 was repeated except that the amount of added urethane acrylate oligomer (produced by Arakawa Chemical Industry Co., Ltd.) was changed to 60 parts by weight and 50 parts by weight of N-vinylcaprolactam was used in place of 50 parts by weight of isobornyl acrylate. The results are given in Table 1.

[0048]

10 Comparative Example 1

The same procedure of Example 1 was repeated except that 110 μm thick low-density polyethylene film (trade name: Sumikathene L705) was used as the substrate film. The results are given in Table 1.

15 [0049]

Comparative Example 2

The same procedure of Example 1 was repeated except that a 100 μm thick film of ethylene/vinyl acetate copolymer (vinyl acetate content: 12% by weight) was used as the substrate film. The results are given in Table 1.

[0050]

Comparative Example 3

The same procedure of Example 1 was repeated except that a 110 μm thick film of ethylene/methyl methacrylate copolymer (methyl methacrylate content: 6% by weight) was used as the substrate film. The results are given in Table 1.

[0051]

Comparative Example 4

The same procedure of Example 1 was repeated except that a
110 μm thick film of ethylene/methacrylic acid copolymer
5 (methacrylic acid content: 8% by weight) was used as the substrate
film. The results are given in Table 1.

[0052]

Comparative Example 5

The same procedure of Example 1 was repeated except that
10 a 100 μm thick polyethylene terephthalate film was used as the
substrate film. The results are given in Table 1.

[0053]

Table 1

	Maximum of $\tan \delta$ (-5 to 80°C)	Young's modulus (kg/cm ²)	Film thickness (μm)	Film thickness x Young's modulus (kg/cm)	Back grinding aptitude
Example					
1	0.78	1100	110	12.1	Good
2	0.85	2400	110	26.4	Good
3	1.18	1400	110	15.4	Good
4	1.05	100	300	3.0	Good
5	1.61	120	250	3.0	Good
6	0.81	3000	110	33.0	Good
Comparative Example					
1	0.19	1300	110	14.3	Dimpled, wafer broken
2	0.16	660	100	6.6	Dimpled, wafer broken
3	0.21	900	110	9.9	Dimpled,
4	0.17	1300	80	10.4	Dimpled, wafer broken
5	0.03	35000	100	350.0	Dimpled, wafer broken

[Document] ABSTRACT

[Abstract]

[Object]

5 The invention provides an adhesive sheet, which is stuck to
the adherend surface having a great uneven surface, in working
the back surface of the adherend, and used for protection of the
surface.

[Means of solving]

10 The adhesive sheet of the present invention is characterized
by providing the adhesive layer on a substrate having a maximum
value of dynamic viscoelasticity $\tan \delta$ of at least 0.5 at a
temperature of from -5 to 80°C.